AMATEUR WORK

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A MERCURY AIR-PUMP.

Robert Gibson Griswold.

To the amateur experimenting in the realm of physics, an air-pump is an necessity, and the one herein described will be found most simple in its construction and operation; and far better than the common piston pump, as the latter will exhaust only to a point at which the tension of the air is insufficient to operate the small silk valves.

In such operations as exhausting a Geisler tube or an "X Ray" tube, the degree of exhaustion must be high, and at the same time readily controled. While this style of pump is slower in action at first, it produces a much more perfect vacuum then the piston style, and its final action is quicker. A tension of one one-hundred thousandth of an atmosphere may be produced if the pump is well made and every joint rendered perfectly air tight.

Make the base *a*, as heavy as convenient, and at least 18″ square. The pump must be as solid as possible as, if accidentally overturned, the loss in mercury and possible breakage of the gauge would be considerable. Make the upright *b*, of 1″ pine, 5 ′ x 6″ and glue it into the base as well as securing it with a couple of screws put through the bottom. The bottom *c*, is glued on as shown to render the upright more firm, and the brace *d*, should be glued as well as screwed in position. Make *e*, 1″ square, and 7″ long, gluing and screwing it to the top of the upright as indicated. The apparatus shelf is placed at a convenient height for holding apparatus while working. It should be at least 7″ square.

The stop-cocks *f*, are of the ordinary $\frac{1}{8}$″ pet variety. Secure two in which the plugs fit very neatly. Remove the plugs by loosening the screw in the end and grind them to a better fit by using ground glass and oil. When the surfaces are smooth, wipe all glass away and coat the plug well with soft tallow. Screw the washer on only tight enough to cause the plug to turn with a slight resistance.

Now file one of the cocks to a flat on one side and drill a $\frac{1}{16}$″ hole *g*, through to the hole inside. Then make a close fit as possible between the two cocks, and solder them together at right angles as indicated at *f*, Fig. 1, but at such a distance apart that the plug handles will not interfere. A section through the middle of these cocks and the reservoir is shown in Fig. 2. The soldering can best be done by the "wiping" method so much used by plumbers for lead pipe joints.

To the end of one cock solder the T *h*, Figs. 1 and 2, made by soldering at right angles two pieces of $\frac{1}{8}$″ brass tubing as shown; the branch is attached to the glass gauge by a rubber tube, while the removing free end is for attaching apparatus.

The reservoir is made from a piece of 1″ brass tubing 6″ long. The conical ends *k*, are made from $\frac{1}{32}$″ sheet brass. Two may be cut from a 2 $\frac{1}{2}$″ circle as in Fig. 4, each covering an arc of 144°. Each piece is then rolled into a funnel and soldered along the abutting edges. The apex may then be filed off until the resulting hole is

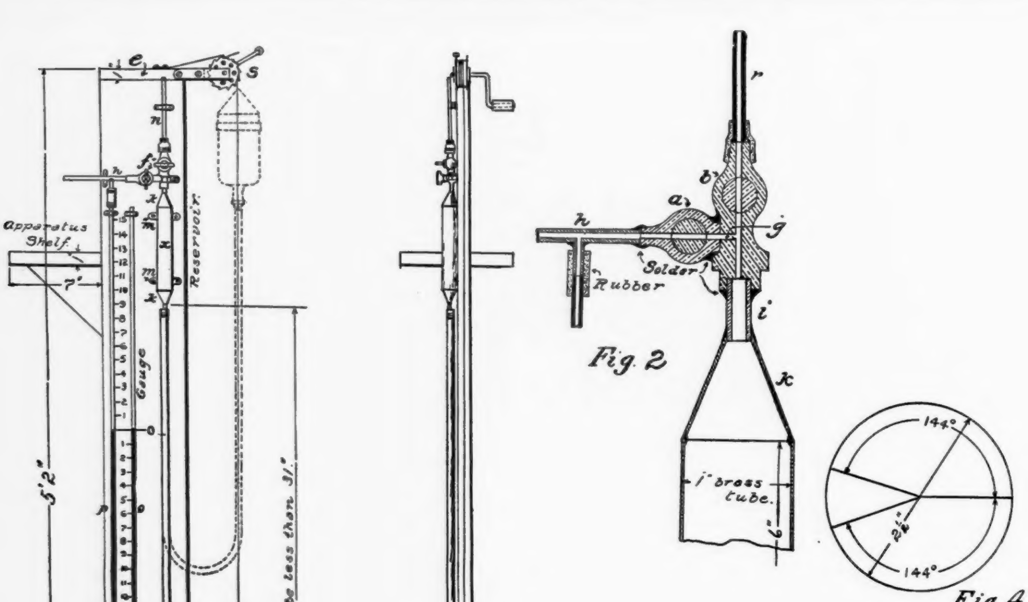

Fig. 1 Fig. 2 Fig. 3 Fig 4

just large enough to admit the tube *i*. The funnels are then soldered to the larger tube as shown, and one end soldered into the vertical stop-cock, as shown in section in Fig. 2. Insure that these joints are well soldered.

The object of the reservoir is to provide a larger space into which the air from any vessel being exhausted may flow. Small clips *m*, are soldered to these parts, by means of which they may be screwed to the stand.

The gauge is made of a piece of $\frac{1}{8}''$ glass tube, bent into a U, each leg being about 31″. If a glass tube of this length cannot be secured, make each leg of a single piece, and connect with a short piece of rubber tube. Join to the branch of *h*, by slipping a piece of fine rubber tubing over the joint, and wrapping silk thread or fine wire around each side of the joint.

The scale divisions shown are inch divisions, and should be further divided into tenths; the scale reading from 0 to 15 on either side. Such divisions enable the true height of the barometric column, for such it is, to be read, despite the alteration in the length of the mercury column, due to changes in temperature. As the degree of exhaustion progresses, the pressure of the atmosphere upon the mercury in leg *o*, drives the mercury up into the leg *p*, such movement depending

of course upon the degree of exhaustion in the vessel attached to *h*. The sum of the distances from the zero division to the top of either column of mercury is equal to the total length of the mercurial column or barometric height. A perfect vacumn will sustain a column of mercury 30″ long. The scale can best be laid off on cardboard, and then secured to the stand underneath the gauge. Drop mercury into the open end of the leg *o*, until it stands at the zero line in both legs.

The mercury reservoir *r*. is made by cutting the bottom out of a glass bottle (pint size) with a red-hot poker. The stopper, which is best made of rubber, is fitted with a glass tube and both the tube and stopper cemented in place with shellac. A stirrup of wire is made to hold the inverted bottle, each wire being soldered to a brass or tin strip which encircles the top. This wire should be about No. 16 iron, and the supporting wire running up to the windlass may be a piece of picture wire which is strong and flexible.

The glass tube extending through the stopper is connected with the lower end of the reservoir by a heavy walled rubber tube of $\frac{1}{8}$″ bore. After slipping over each tube firmly, bind each end with wire as the mercury is very heavy. A tube four feet long will be sufficient. The position of the bottle when elevated is indicated by dotted lines.

The windlass *s*, is made by fastening to the sides of a two inch disc of wood, two brass discs 2 $\frac{1}{4}$″ in diameter, one of which has its periphery provided with a series of teeth filed in to engage with a spring paw The crank may be bent out of a piece of $\frac{3}{16}$″ brass wire, and the drum secured to it by soldering on both sides. Support the drum by passing the shaft through $\frac{3}{16}$″ holes in the ends of two pieces of $\frac{1}{8}$″ flat brass or iron, which are then fastened to the piece *e*, with screws or small bolts passing directly through. The spring pawl *t*, is secured in such a position that it will readily engage with the teeth and hold the mercury reservoir securely.

The mercury for use in this pump need not be of the refined quality; that known as "commercial" being quite good enough and far cheaper.

To operate the pump, connect the flask or tube to be exhausted to the free end of *h*, by a thick walled rubber tube, wrapping the joints with a few turns of copper wire. Close cock *a*, Fig. 2, and open *b*. Then wind up the windlass until the mercury reservoir is near the top and the mercury is just visible above the rubber connection in the glass tube *n*. The reservoir *x*, and rubber tube will then be full of mercury and all air expelled. Now close *b*, and lower the reservoir *r*, to its lowest position. The mercury will run out of *x*, leaving a vacumn. Then open *a*, and the air in the flask will rush in to fill the vacumn; at the same time the mercury in the guage leg *p*, will rise to a certain point, indicating that the tension of the gas in the flask is decreasing. Then close *a*, open *b*, and again wind the reservoir *r*, up so as to completely fill the apparatus as before. By repeating this operation a number of times, the vacuum will become almost perfect, as will be indicated by the column *p*, coming to rest at 15, and not being influenced by further repetitions of the above process.

If it is a Geisler or X Ray tube that is being exhausted, it may be sealed at any desired point by applying a blowpipe flame. The softened glass will be pressed together by the outer atmospheric pressure, and a perfect seal made. By passing an electric discharge through the tube during the process of exhaustion the proper point at which to stop can readily be determined.

In dry air at 82 degrees, sound travels 1,142 feet per second, or about 775 miles per hour; in water, 4,900 feet per second; in iron, 17,500 feet; in copper, 10,378 feet; and in wood from 12 to 16,000 feet per second. In water, a bell heard at 45,000 feet, could be heard in the air out of the water but 656 feet. In a balloon the barking of dogs can be heard on the ground at an elevation of four miles. Divers on the wreck of the Hussar frigate, 100 feet under water, at Hell Gate, near New York, heard the paddle wheels of distant steamers hours before they hove in sight. The report of a rifle on a still day may be heard at 5,300 yards; a military band at 5,200 yards. The fire of the English on landing in Egypt was distinctly heard 130 miles. Dr. Jamieson says he heard, during calm weather, every word of a sermon at a distance of 2 miles.

WOOD TURNING FOR AMATEURS

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X. EXERCISES IN ORNAMENTAL TURNING.

CANDLESTICK.

Fig. 78, is a pleasing design for a candlestick. This may be made from bass wood and fire etched, or from any fine grained hard wood. I have used bird's eye maple for this exercise, with good success; if the turning tools are kept sharp, and the candlestick carefully sandpapered with fine sandpaper, no difficulty should be experienced because of the breaking out of the "eyes" in the maple.

For this exercise two pieces of stock are required. The standard is turned from a piece 2 $\frac{1}{8}$" square, and 6 $\frac{1}{2}$" in length, while the base requires a piece 4 $\frac{3}{4}$" square, and 1" in thickness. The standard shown in Fig. 79, may be turned between centres, but, as the candle end must be either turned or bored out, it will be found much easier to put the block on the screw centre.

The stock is first turned down to the largest diameter 1$\frac{7}{8}$". The free end of the block is to be turned down for the candle end of the standard, so the T rest is next turned around, as in face plate work, and the cup hollow, which is $\frac{1}{4}$" deep and 1 $\frac{1}{16}$" in diameter, is turned with the $\frac{1}{4}$" round nose chisel, after the end surface has been trued up with the skew chisel. A hole, $\frac{3}{4}$" deep. and $\frac{3}{4}$" in diameter, to receive the candle is next to be cut in this end. This hole may be bored out to size with a twist drill, or bored out with a small drill and then finished with a round nose chisel and $\frac{3}{8}$" skew chisel. If the stock used is hard wood, the second method will be found to be the safer one, as a large drill will be quite liable to catch in the revolving block and may either tear the block from the screw centre, or else "throw it out of true".

A small V shaped opening should be cut in the centre of the end, by means of the acute corner of the $\frac{3}{8}$" skew chisel, this opening being used to start the bored hole. The amateur's lathe should be equipped with a small steel chuck, with the shank turned to the same taper as the head and tail centres. There are many kinds of chucks on the market, but I have found that the best one for general work of this class, is the "Beach Chuck" made by the Morse Twist Drill Company of New Bedford, Mass.

If one of these chucks is available, it should be placed in the tail spindle, the tail stock being clamped rigidly to the shears so that a $\frac{1}{4}$" or $\frac{3}{8}$" drill may be forced into the wood by advancing the tail spindle. The block, of course, revolves while the drill does not. The depth of hole, $\frac{3}{4}$", may be marked on the drill before starting to bore. If the amateur has no chucks, the drill may be placed with the cutting end in the small V opening. and the other end against the cup centre, held in the tail spindle. The drill is prevented from turning by holding the end in a wrench.

Whenever boring is to done with a drill held in a chuck or against the tail centre, the driving belt should be run at the slowest speed. When the hole has been finished to $\frac{3}{4}$" diameter, draw up the tail stock, clamp it, and adjust the tail centre, unless it be larger than $\frac{3}{4}$" diameter so that the spur is forced a very little way into the block at the bottom of the hole, thus supporting the free end of the block and making it impossible for the block to "run out of true" during subsequent turning operations.

Finish the end next the tail centre first, and the tenon at the end next to the screw centre last. This tenon, which fits into a hole in the base, should be turned to exactly $\frac{1}{2}$" diameter. After sandpapering, remove from the lathe, if the candlestick is to be fire etched. If made from hard wood, finish with white shellac exactly the same as the Indian Clubs described in the June number.

The base, shown in Fig. 80, is to be turned on the screw centre, a thin piece of pine, planed on both sides, being used for a back piece for the planed side of the block to come up against.

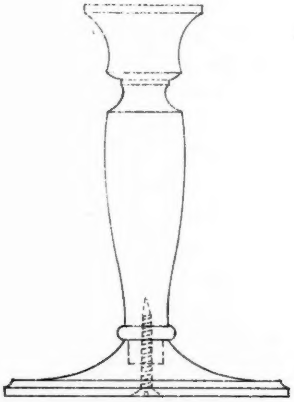


Fig 78

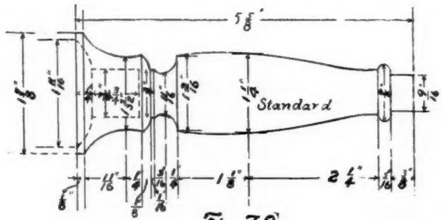


Fig 79

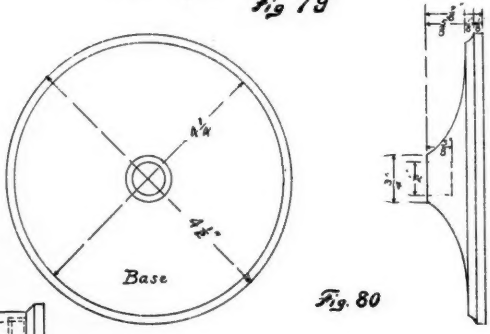


Fig. 80

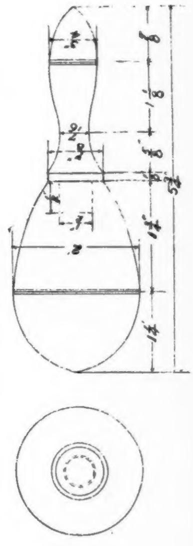


Fig. 81

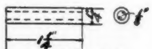


Fig 84

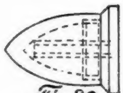


Fig. 82

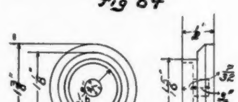


Fig 83

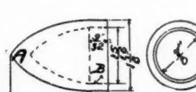


Fig. 85

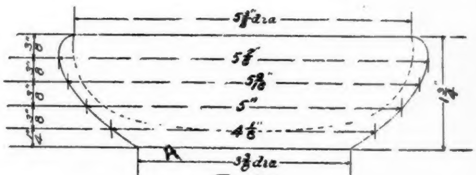


Fig. 86

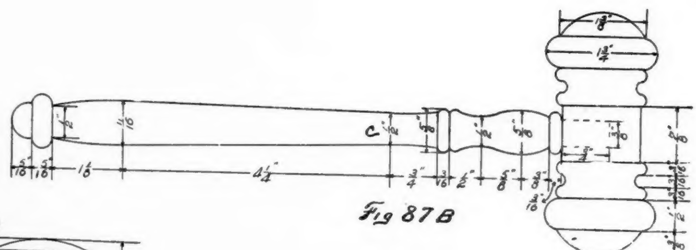


Fig 87 B

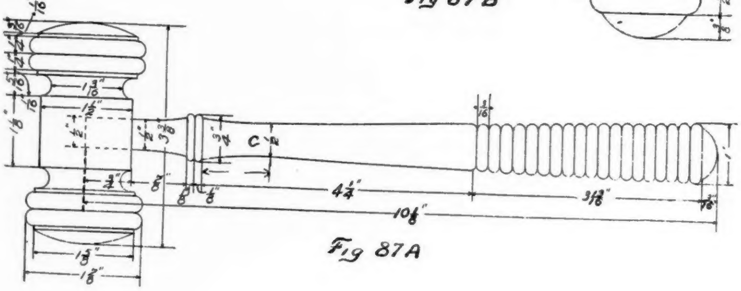


Fig 87 A

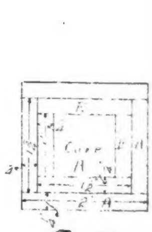


Fig 88

This back piece is necessay in orrder that the edge of the block can be turned without striking the surface of the screw centre, and also to keep the screw from going into the block for too great a distance, thus preventing the turning of the hole for the tenon of the standard. The round nose chisel may be used for turning the curved surfaces of the base. If the screw of the screw centre prevents the turning or boring of the hole, the base may be chucked and finished up, or bored with an auger bit, while held in a wooden clamp.

The standard should be glued to the base, and if desired, a 1 ½″ No. 10, wood screw may be used as shown in Fig. 78.

STOCKING DARNER.

This exercise may be turned from one piece of stock, or made in two pieces, as shown in Fig. 81, the handle being tenoned into the ball, thus saving considerable stock. The ball may be glued up of alternate pieces of gumwood and pine with a gumwood handle; or black walnut and oak may be used with the handle of black walnut. In either case use strips ¼″ thick, as eight strips will give the required thickness 2″. The stock should be 2 ¼″ wide and the two outside strips ⅜″ thick so as to form a block 2 ¼″ square, and 4 ¼″ long, when glued up. The ball may be turned between centres but must be finished in a chuck. Care must be taken in chucking to prevent the ball from "running out of true." The chuck should be turned out to as near the same curve of the ball as possible, so as to give a good bearing surface. The handle requires a piece of stock 4″ long, and is turned between centres, being tenoned into the ball, the same as the standard in the previous exercise. It should fit tightly and is to be glued and clamped until the glue is perfectly hard.

If desired, the stocking darner may be made from rock maple and dyed black. This. when stained and finished with white shellac, will give a splendid imitation of Ebony, both in richness of color and fineness of grain.

This ebony finish may be given to any wood by using a water stain made by dissolving two ounces of logwood in one quart of water or by dissolving half an ounce of the logwood in three ounces of alcohol. This logwood stain is to be followed by a solution of iron, using one ounce of sulphate of iron to one quart of water. A less intense black may be obtained by using one ounce of sulphate of iron in three quarts of water.

Black walnut and oak are open grained woods, so that the pores of the wood must first be filled, before a varnish finish can be produced.

NEEDLE AND THIMBLE CASE.

This little exercise, Fig. 82, should be turned from soft woods or fine grained hard woods, and requires careful turning to make the cover fit the base nicely. The cover may be made from ⅛″ strips of gumwood and pine, the two outer strips being ¼″ thick, and the base from gumwood, the needle case being made from a ¼″ birch or maple dowel.

The base, Fig. 83, is turned first, a block 1 ⅝″ square, and 1 ½″ long being placed upon the screw centre. This block will be long enough to permit the base to be turned and cut off without coming in contact with the screw. The rim at *A*, Fig. 83, over which the cover fits, is only $\frac{1}{16}$″ in thickness, so that care must be taken in turning this not to split it. The needle case, Fig. 84, can only be used with an open end thimble. If this is to be used, bore or cut the hole in the base ¼″ in diameter, and $\frac{3}{16}$″ deep. The dowel, which is 1 ¼″ long, is held in a vise or clamped, and bored out with a ⅛″ drill or gimlet bit.

The cover may be turned in two ways. The first method requires a block 2 ½″ long, the block being put on the screw centre. The outside surface is turned to 1 ⅛″ diameter and the curve approximately turned, the point *A*, Fig. 85, being next the screw centre. At this point *A*, a diameter of ½″ should be left. The T rest is now brought round across the end and the inside hollowed out large enough to fit the thimble, the shoulder at *B*, Fig. 85, being made to fit the rim at *A*, Fig. 83. This recess may be started with a small drill if desired. The inside of the cover is now to be sandpapered and the block removed from the screw centre and cut apart. A pine block is next put on the screw centre and a round plug turned 1$\frac{5}{16}$″ diameter and the cover fitted to this, or a hole may be cut in the block 1 ⅛″ in diameter and the cover chucked. The outside surface is then finished and sandpapered. The dowel should not be glued in, as it would

prevent the use of the case for holding a thimble with a closed end.

The second method of turning the cover requires a shorter piece of stock as the outside surface is turned and finished first, the point *A*, Fig. 83, being farthest away from the screw, which enters wood which is later to be removed. The block must be chucked in order that the inside may be hollowed out. The first method, I believe, is the better one, as the second method requires very careful chucking.

NUT BOWL.

Models of the shape shown in Fig. 86, are much used for fire etching, being turned from bass wood. A very pretty bowl can be turned from apple wood, or bird's eye maple. Fig. 86, gives sufficient dimensions so that a curve for a templet for an outside surface may be easily drawn. This templet will be found to be very useful, especially if duplicates of the bowl are desired. The dotted lines shows the inside curve of the bowl. The dimensions given for the thickness of the bowl are sufficient for the drawing of the templet for the inside curve.

If possible, use a block at least 2 ½″ thick, so that, after the bowl has been turned, the bottom surface at *A*, Fig. 86, can be shouldered down with the parting tool and ¼″ skew chisel, without striking the screws which fasten the block to the face plate. ¾″ screws will be long enough for this work. The block, which must be thoroughly seasoned, is to be roughed down at the next to the slowest speed. The inside surface, which is finished last, is to be finished with the ⅜″ round nose chisel.

GAVELS.

Fig. 87, shows two styles of gavels. The heads may be made of glued up pieces if desired, but the handles had better be turned from a solid block of wood. Fine grained woods should be used, especially for the handle of the gavel at *A*, Fig. 87. Four gavels were recently turned by students in the writer's classes in wood turning. The first one was turned from white hickory, care being taken in the selection of the wood, so that none of the dark heart wood appeared. The second gavel was turned from apple wood; if this wood is well seasoned, the effect produced is very pleasing.

The third gavel had a rosewood head and a cocabola handle. The head of the fourth gavel was made from glued up pieces of Ebony and Amaranth with an Amaranth handle. The arrangement of the pieces in gluing up this head is shown in Fig. 88, the head being for the gavel shown at *B*, Fig. 87. In Fig. 88, all parts marked *A*, are Amaranth and the parts marked *E*, are Ebony.

The handles are readily turned, the one shown at *A*, Fig. 87, being the most difficult because of the series of graduated beads. The straight taper, closely approximating the finished size, should be turned before the beads are started. In turning these handles, the parts marked *C*, in both figures, should be finished last, in order to lesson the vibration of the handle. Care must be used in sandpapering not to flatten the beads.

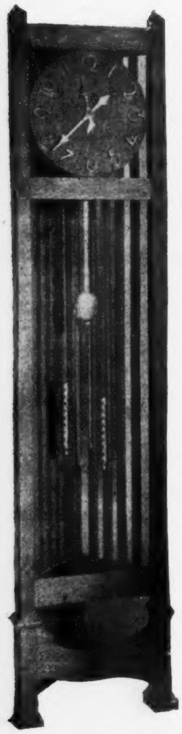
The ends of the head are to be finished in a chuck. This involves patience, as it will not do to attempt to finish these ends if they run out while in the chuck. Oftentimes in an exercise of this kind the turner, in order to avoid the extra work of chucking the block, will be tempted to cut the ends off, finishing the block with a chisel, file, or sandpaper. This method will not be satisfactory in getting a smooth curve on the ends of the gavel heads.

When the head and handle have been finished, a hole must be bored in the centre of the head to receive the end of the handle. This centre must be marked very carefully. In boring the hole, the head should not be clamped in the vise, as it might become bruised. Make a large V shaped cut of 90° in a block nearly as thick as the length of the head. This will support the head so that it may be bored without difficulty. The gavel should be finished with white shellac and rubbed down with pumice stone and oil, as has been previously described.

It is stated that the extensive irrigation works lately developed in Egypt, have increased the moisture in the atmosphere to such an extent that the Sphinx is rapidly crumbling to pieces.

A CORNER CLOCK.

H. M. Chadwick.



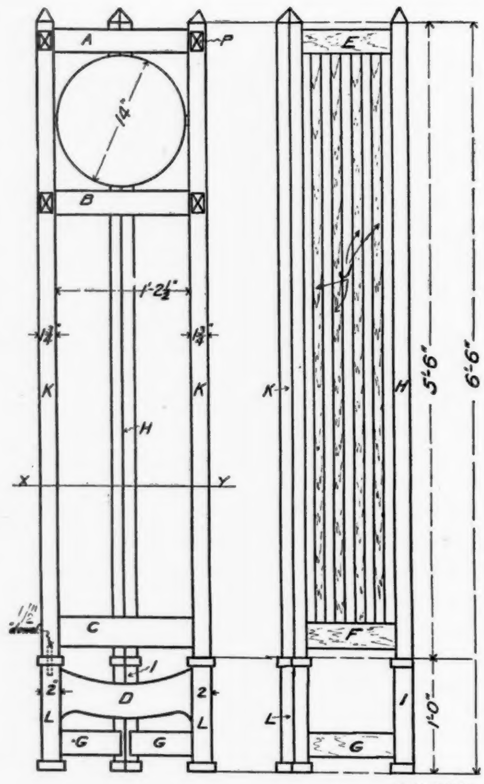
This clock is made after the same general style as the Dutch Clock described in the December, 1901, number of Amateur Work It is built, however, in the form of a right triangle, so that it will stand in the corner of a room, thereby occupying the least possible space.

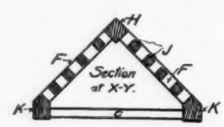
The material is well seasoned oak, with pieces *A-B-C-D*, and the dial of quartered oak. Pieces *A* and *B*, are $2\frac{1}{2}''$ x $\frac{7}{8}''$ with $2''$ x $\frac{1}{2}''$ tenons, *C*, is $3''$ x $\frac{7}{8}''$ with $2\frac{1}{2}''$ x $\frac{1}{2}''$ tenons, *D*, is $4''$ wide, at the centre x $\frac{7}{8}''$ thick, and has $3''$ x $\frac{1}{2}''$ tenons. *E-F* and *G*, are $2\frac{1}{2}''$ x $1\frac{1}{4}''$, with $2''$ x $\frac{1}{2}''$ tenons.

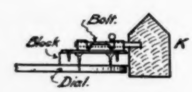
All tenons are $1''$ long, *H*, is $1\frac{3}{4}''$ square, *I*, is $2''$ square, *J*'s are $1''$ square, with $\frac{1}{2}''$ round wodels glued into the ends to serve as tenons. *K*'s are $1\frac{3}{4}''$ wide, on front and sides. The two back faces of *K*, are beveled so that *F*, will stand at an angle of 45° with *C*. *L*, is $2''$ where *K*, is $1\frac{3}{4}''$, and is beveled like *K*.

P, is a four-sided pyramid $\frac{1}{2}''$ high, glued to *K*.

The top of *K*, is beveled to a five-sided pyramid whose apex is over the centre of the square portion.







The dial is supported on each side by a small door-bolt screwed to a block, which in turn is screwed to the back of the dial. Bore a hole in *K*, to take tne bolt shaft. The top and bottom of the dial should also be held to keep it from tipping forward.

The clock movement may be obtained from the Waterbury Clock Co. of Waterbury, Conn., at a cost of about \$7.00. This price includes black iron weights. The weights shown in the photograph are of lead, with brass shells and cost \$1.50 more than the black ones.

The pendulum may be improved in appearance by having fastened to it a raised brass letter of Old English style, preferably the family initial.

The movement is mounted in a rectangular wooden box without a cover, and is screwed to the bottom thereof. Make the box as small as possible and fasten to the back of the dial by means of four small brass hinges or angle pieces.

PROJECTION.

CARL H. CLARK.

X. EXAMPLES OF ISOMETRIC PROJECTION.

Having described the methods used in isometric projection we will now take up some illustrations of the application of these principles. Fig. 30, is the isometric projection of a box obtained as follows: Starting with *B*, fhe width *A-B*, the height *B-b*, and the length *B-C*, are laid off; then from *B*, the lines *b-a*, and *b-c*, are drawn and also *a-d*, and *c-d*. Drawing *A-a*, and *C-c*, completes the outline.

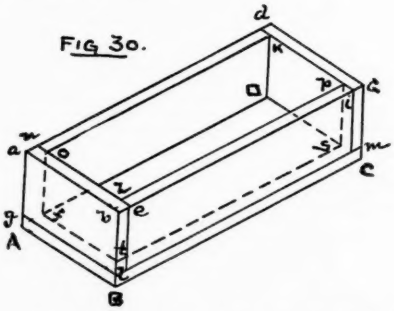


FIG 30.

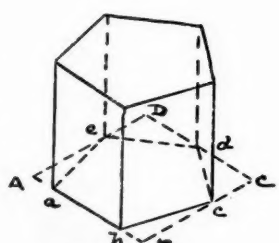


FIG 31.

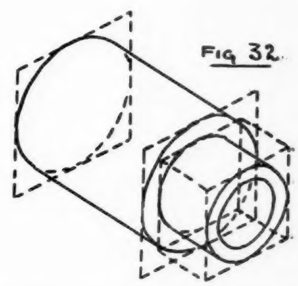


FIG 32.

The thickness of the bottom is *A-g*, and this height is laid up from *B*, and *C*, giving *g-l-m*, as the edge of the bottom; *b-e*, and *c-i*, are the thickness of the ends, and *e-n*, and *i-k*, are the edges of the ends, *e-h*, and *d-k*, are the thickness of the sides drawn as before. Verticals from *o-k-p*, give the inside corners, and the lower inside corners may be obtained by laying back from *g*, the thickness of the side and drawing *f-d*; and laying back from *m*, the thickness of the end and drawing *D-S*.

These corners are full lines only where they are not concealed by the sides and ends, the corners *f-t*, and *t-s*, are obtained similarly.

Fig. 31, is the isometrical projection of a pentagonal prism. As before described, the rectangle *A-B-C-D*, is first circumscribed about the base, and the isometrical projection of the pentagon gotten as before by laying off *A-a*, *B-b*, *B-c*, and *A-e*, from the plane figure, *d*, will of course be in the middle of *C-D*. To obtain the upper face we could, if desired, go through exactly the same process after laying off the height, but since all the edges are equal, all that is necessary is to lay off the height on verticals from the corners *a-b-c-d-e*, and connect the points thus found.

If this were a pyramid, all that would be necessary would be to locate the apex and draw the edges as before. Fig. 32, is the isometrical projection of a cylinder with a smaller cylinder projecting from the end. It is first necessary to draw the circumscribing prisms of the proper length, and with the ends the same dimensions as the diameter of the cylinders; the projections of the circular ends are then obtained as before described.

At the last meeting of the Medical Society of Berlin, at which were present many of the most eminent medical scientists of Germany, there was presented by Dr. Danelius and Prof. Theodor Sommerfeld, an elaborate thesis describing their experiments with a new system of treatment for tubercular disease by inhalation, or rather fumigation, with the combined fumes of eucalyptus, sulphur, and charcoal. These experiments have been a subject of keen and sustained interest among the foremost medical men of Berlin during the past six months. The high authority of the tests made and the encouraging nature of the results reported, constitute an important step towards the scientific mastery of a disease which has become one of the most widespread and fatal scourges of the human race.

ELEMENTARY SHOP PRACTICE.

Frederick W. Turner, Rindge Manual Training School, Cambridge, Mass.

VII. PIPING.

One of the operations which the amateur workman never escapes, is pipe fitting in some of its several branches. As taps and dies are largely used in this work, a description of pipe fitting will naturally come after the section on taps and dies which appeared in the last number.

The pipe which is used for nearly all steam and water connections is called "standard wrought iron pipe", while for very high pressures, "extra strong" and "double extra strong" are employed. The outside diameter of all three varieties is the same in any given size; the heavier wall being always obtained by reducing the internal diameter. The result is that the actual inside diameter of standard pipe is much larger than the nominal diameter. For example, a $\frac{1}{8}''$ standard pipe is actually .27″ or more than $\frac{1}{4}''$ in internal diameter, a $\frac{1}{2}''$ pipe is almost exactly $\frac{5}{8}''$ inside, etc.

die, similar to that used in butt-welding, with a ball or "tipple" held by a long rod directly in the die opening. In this case, the welding is done by pressure between the die and tipple.

Pipe is ordinarily sold in lengths of about 18 feet, and provision is made for joining the lengths by threading both ends. This thread is like the V thread with a slight rounding at top and bottom, but instead of being straight like ordinary bolt threads, it is tapering at the rate of $\frac{3}{4}''$ per foot. As the fittings are tapped out with a similar taper, the joint is "made up" tight in the threads themselves. Each length of pipe is provided with a "coupling", so that the pipe as bought can be run in a straight line without additional fittings.

The following table is introduced as showing all the necessary details of measurements.

Nominal inside. Inches.	Actual inside. Inches.	Actual outside. Inches.	Thickness of wall. Inches.	Weight per foot. Lbs.	Inside Area Inches.	No. of thrds per Inch.	Size of tap drill. Inches.
$\frac{1}{8}$	.270	.405	.068	.241	.057	27	$\frac{21}{64}$
$\frac{1}{4}$	.364	.540	.088	.420	.104	18	$\frac{29}{64}$
$\frac{3}{8}$	.494	.675	.091	.559	.192	18	$\frac{19}{32}$
$\frac{1}{2}$	.623	.840	.109	.837	.305	14	$\frac{23}{32}$
$\frac{3}{4}$	.824	1.050	.113	1.115	.533	14	$\frac{15}{16}$
1	1.048	1.315	.134	1.668	.863	$11\frac{1}{2}$	$1\frac{3}{16}$
$1\frac{1}{4}$	1.380	1.660	.140	2.244	1.496	$11\frac{1}{2}$	$1\frac{15}{32}$
$1\frac{1}{2}$	1.610	1.900	.145	2.678	2.038	$11\frac{1}{2}$	$1\frac{23}{32}$
2	2.067	2.375	.154	3.609	3.355	$11\frac{1}{2}$	$2\frac{3}{16}$
$2\frac{1}{2}$	2.468	2.875	.204	5.739	4.783	8	$2\frac{11}{16}$
3	3.067	3.500	.217	7.536	7.388	8	$3\frac{5}{16}$

The pipe is made by rolling a flat strip, called skelp, into the circular form and welding the joint. Pipes up to 1″ have the edges of the skelp square and are "butt-welded" by being drawn through a die while the edges are at a welding heat; the larger sizes have scarfed edges and are "lap-welded" by being drawn through a

If the hole is not to be reamed out tapering previous to tapping, a drill about $\frac{1}{32}''$ larger than that given in the table would be desirable.

This table does not apply to gas pipe, as such pipe is weaker than standard pipe and has 27 threads per inch on all sizes.

Changes in direction and diameter are made by

means of either malleable iron or cast iron fittings. The malleable fittings are neater in appearance, but somewhat more expensive, than the cast iron fittings, which must be made heavier, and therefore more clumsy in appearance, on account of the weakness of the material. A change of 90° in direction is made by the "elbow," which is really a coupling bent at right angles. It is named, as is the case with all fittings, according to the size of the pipe on which it is to be used; 45° elbows are also used to some extent. Where a branch is to be taken from a straight run, a combination of a coupling and an elbow, called a "tee," is used. A double tee or "cross" is also a common fitting.

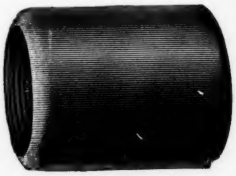


Fig. 56. Coupling.

Fig. 57. Elbow.

Fig. 58. 45° Elbow.

Fig. 59. R. & L. Elbow,

Fig. 60. Reducing Elbow.

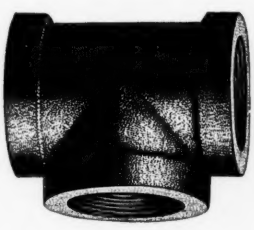


Fig. 61. Tee.

Fig. 62. Cross.

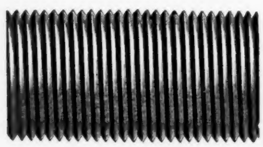


Fig. 63. Close Nipple.

Fig. 64. Bushing.

Fig. 65. Union.

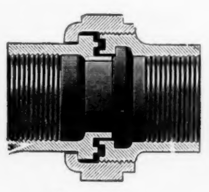


Fig. 66. Section of Union.

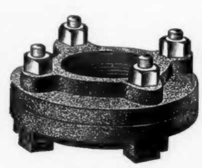


Fig. 67. Flange Union.

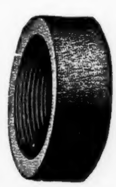


Fig. 68. Cap.

Fig. 69. Plug.

For change in diameter, a "bushing" is the simplest fitting. This can be inserted in a coupling, elbow, tee or cross and a smaller pipe made into it. For this purpose of reduction, the coupling, elbow and tee are also made with one end smaller than the other, usually not more than one size, however. Thus we have the "reducing elbow" and "reducing tee". In these cases, the name of the fitting must include both pipe sizes; for example, $\frac{3}{4}''$ x $\frac{1}{2}''$ coupling or $1''$ x $\frac{3}{4}''$ elbow.

In giving the size of a tee, the straight passage or "run" is always named before the side outlet or "branch." A tee which is tapped $\frac{3}{4}''$ all round is called a "$\frac{3}{4}''$ tee". Should the branch be $\frac{1}{2}''$, its name would be "$\frac{3}{4}''$ x $\frac{1}{2}''$ tee", the $\frac{3}{4}''$ referring to the straight run and the $\frac{1}{2}''$ to the branch. If this same tee is reduced from $\frac{3}{4}''$ to $\frac{1}{2}''$ on the run, its name would be a "$\frac{3}{4}''$ x $\frac{1}{2}''$ tee." When the branch of a tee is larger than either opening on the run, it is called a "bull-head tee." The cross is the same size all round as "1'' cross"

AMATEUR WORK

63 KILBY ST., BOSTON

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Entered at the Post-office, Boston, as second-class mail matter Jan. 14, 1902.

JULY 1903.

When requesting a change of address, subscribers should give the old, as well as the new, address in full.

The publication of *The Model Electrical and Mechanical Engineer* having been discontinued, by arrangement with the publisher, R. Thistlewhite, all unexpired subscriptions will be completed with Amateur Work.

We take pleasure in announcing the names of those to whom the prizes offered in the April number have been awarded.

Prize No. 1. H. M. Chadwick, Malden, Mass. Subject, A Corner Clock.

Prize No. 2. Albert Graham, Quincy, Mass. Subject, A Closed Circuit Battery.

Prize No. 3. W. J. Lytle, Pittsburg, Pa. Subject, A Club Swinger Wind Vane.

These articles are all published in this number, and will be found of much interest to our readers. Other articles which were submitted, will be published as occasion presents. Other prizes will be offered at an early date, which we hope will be productive of articles of equal interest.

SHOP PRACTICE Cont'd.

or two sizes at right angles as a "1″ x ½″ cross".

All fittings thus far mentioned are supposed to be tapped out right hand, but it is often more convenient to join two sections of piping than to make it up in one continous job, Sometimes, also, it is necessary to open a section of piping, and it is much easier to break it near the point required, than to take it down from the end. This result can be obtained by having the length of pipe in question threaded right hand at one end and left hand at the other. The fittings must be tapped to suit, and so we have the "R. & L. coupling" and the "R. & L. elbow." These fittings are distinguished by parallel ribs in case of a R. &. L. coupling, and by similar ribs on the bead on the left hand end of a R. & L. elbow.

The right and left method of connection requires that the two sections must be capable of being separated about an inch to introduced the right and left length of pipe, both ends must be started together or so they will both make up tight at the same time. This is not always possible or desirable, and, especially where disconnection is almost certain to be required, (for example, the steam and water connections to a pump) the special fitting called a union is used. As the tightness of such a joint depends on the contact between the faces of the union, and not on the thread contact alone, this fitting must be more carefully made, and those of brass are the only kind fit to use for work which is to be at all permanent in character.

The "cap" is a small fitting to stop off a length of pipe, and the "plug" is to stop the unused end of a fitting; coupling, elbow, etc. As it is difficult to thread the ends of very short pieces of pipe, such pieces are sold as fittings, and are called "nipples." If it is so short as to bring the ends of the fittings connected almost into contact, it is called a "close nipple," and if it separates them by two inches, it would be called a "2″ space nipple." These are made up to eight inches.

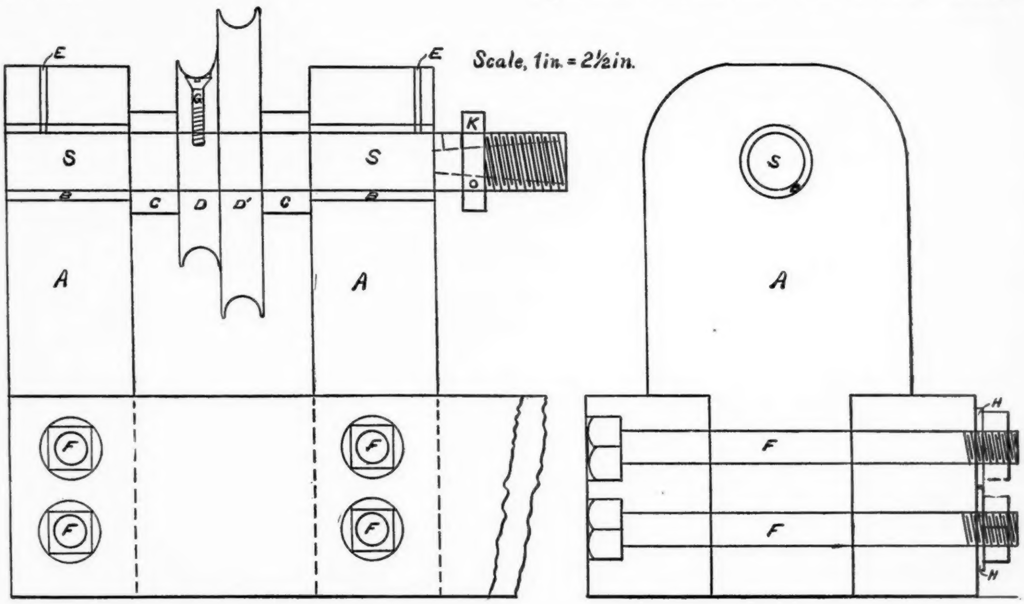
In another article the tools and methods used in making up the simpler forms of piping will be considered.

A SIMPLE TURNING-LATHE.

I. THE HEAD-STOCK.

The amateur who occasionally requires to use a turning lathe, and yet does not care to go to the expense and time of making a more pretentious one, will find a lathe such as is here described very servicable, and with care, excellent work can be done upon it. The headstock will first be described.

These holes are a scant 1 ⅛″ diameter to give a driving fit for pieces of brass tubing ⅞″ diameter inside and with walls ⅛″ thick. The tubing should be obtained first, and the exact diameter outside, be found with calipers. Then an expansive bit is set to bore the holes, and first tested on a piece of waste wood. The fit of the tubing in



The two pieces *A*, in the illustration, are cut out of clear oak, and are 8″ long, 4″ wide, and 1 ⅛″ thick. The lower ends, bolted to the bed, are 2″ wide, and 3″ long, care being used to get the angles and edges square and smooth. The holes for the bolts *F*, are cut and the bolts fitted before cutting the holes for the spindle bearings *B*, the two pieces being placed 2 ¾″ apart. After these two pieces are fitted to the bed, horizontal lines are struck across each side, exactly 3 ½″ above the bed. Then the centre line is located with a straight edge, and with a square strike vertical lines on each side. The points where the lines cross, give the centres for boring the holes for the bearings *B*.

the holes must be tight so that once in place it will stay there. The holes are not bored clear through from one side, but are bored half way from each side, thus overcoming any error in the direction of the boring, provided the starting points have been correctly located.

The pieces of tubing each 1 ¾″ long, are then driven into the holes and after drilling the oil hole *E*, ⅛″ diameter, the pieces *A*, are bolted permanently to the ways. The ways are of maple or clear grained birch, 2″ x 3″ and 36″ long, holes being bored in the front one for the heads of the bolts *F*, which are 6″ long, and ½″ diameter. Washers *H*, are put under the nuts to prevent the latter from cutting into the ways.

The spindle *S*, is a piece of round steel shafting, 8″ long, and ⅞″ diameter. This can be obtained with a smooth surface requiring no finish, care being taken to see that it is perfectly straight. Two collars *C*, are made out of pieces of 1 ½″ shafting ¾″ long, by boring ⅞″ holes in the centre; one collar will require a set screw. The two-step pulley *D-D′*, is made of two pieces of maple or birch, ⅝″ thick, and 5″ square. The surfaces are carefully planed, and then fastened together with glue and screws, the latter being located well in towards the spindle so that the smaller step *D*, can be turned to a diameter of 2 ½″ at the centre of the groove. The larger step is 4″ diameter in the centre of the groove. The pulleys are fastened to the spindle by the screw *G*, which is a large wood screw with the point cut off and filed down to fit a hole drilled a short distance into the spindle, about 2 $\frac{15}{16}$″ from the outer end. The inner end of the spindle is threaded on the outside for about 1 ¼″ to receive a small face plate, to be described. If much face plate work is to be done, a collar *K*, ⅜″ thick and made the same way as the two collars *C*, should be fastened to the spindle by pinning, thus forming a shoulder against which the face plate will bind. A taper hole is also drilled in the end of the spindle to receive centres. As many readers may not be fitted to do the little machine work required, it can be taken to any machine shop and will cost but little if done at one time. To get the proper taper for the hole the spur and pointed centres should first be purchased or made, those purchased being usually of standard taper. A small chuck for drills will also be found very convenient.

A CLOSED CIRCUIT BATTERY.

Albert Graham.

Almost every form of battery has a particular use for which it is especially adapted. But for closed circuit work there are only a very few cells that will last, and work economically for any great length of time. In the cell herein described the materials are very cheap and easily procured, renewals cost but a trifle, and a dozen cells may easily be made for the cost of a single cell of many other types.

The bichromate cell is without doubt the most desirable type for an amateur, as it furnishes a powerful current for the size of the cell, and each unit has a high E. M. F. but if left standing with the zinc element in the electrolyte for any length of time, especially when no current is being used, a continual waste takes place which makes it somewhat expensive.

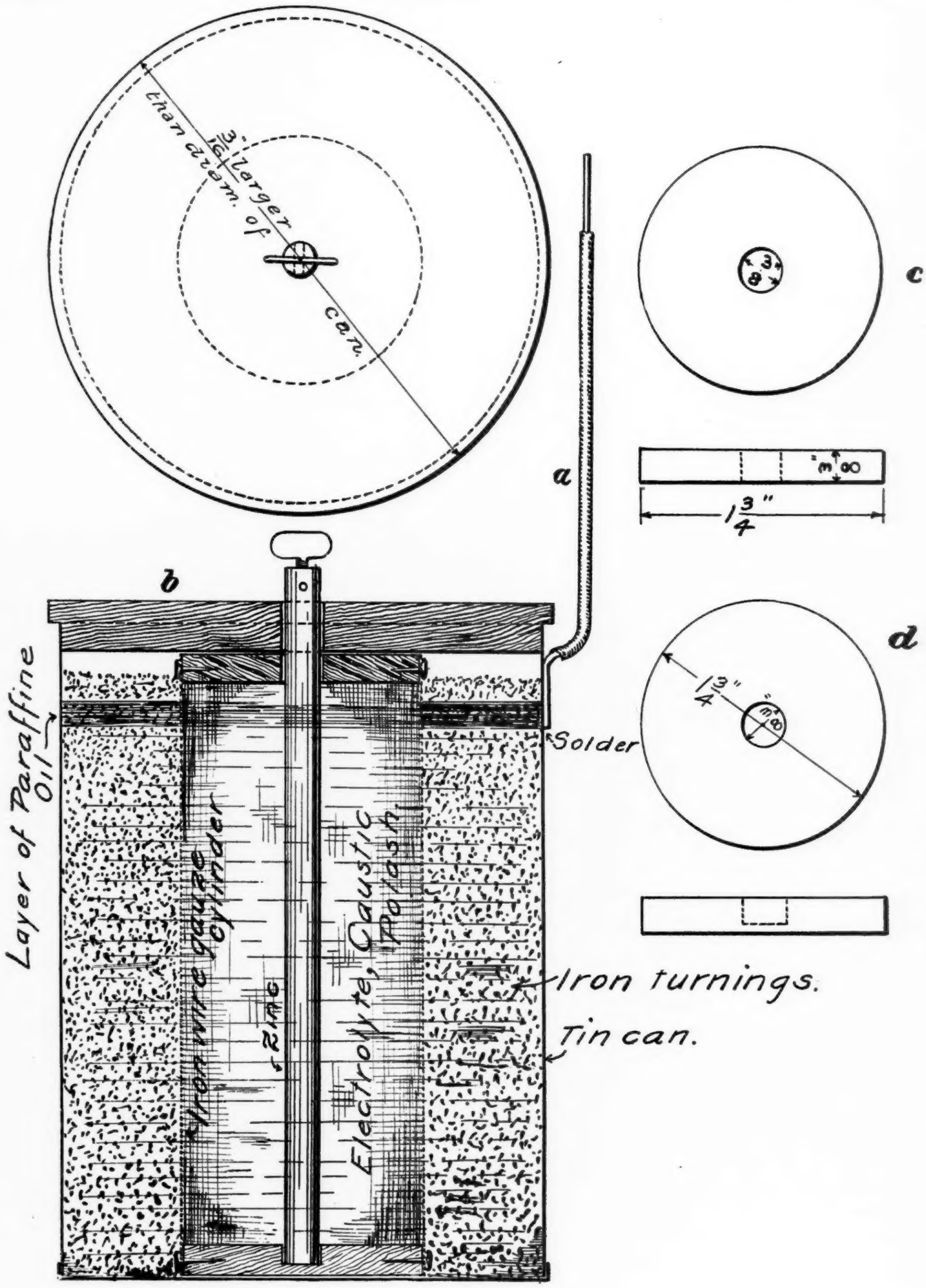
The battery jars in this form of cells are made of ordinary tin cans such as have been used for canning tomatoes, fruit, etc. Secure as many of uniform size, as will make the number of cells desired, and remove the rough top edge by heating until the solder melts and the ragged end piece can be knocked off. This leaves the can with a true top edge. Do not allow the side seam to become unsoldered. Thoroughly cleanse the inside, and also remove the paper label. To one side solder a piece of insulated wire *a*, about No. 14 or 16, and 6″ long.

Turn up a wooden top *b*, so as to fit the can snugly, the larger diameter being about 3-16″ greater than the inside diameter of the can. Its thickness need not be greater than 1-2″. A hole is bored in the centre with a 3-8″ bit to admit the zinc.

Make two discs of wood *c*, and *d*, 1 3-4″ diameter and 3-8″ thick. In one a 3-8″ hole is bored completely through, while in the other it only goes about half way. It is better to make this cup in the bottom piece with a gouge as the end of a bit will penetrate the wood and a small accumulation of dirt would easily short circuit the cell. Boil the three discs in parafin until all bubbles cease to be evolved, which not only makes them impervious to moisture but renders them excellent insulators.

Make the inside cylinder of iron wire gauze of about No. 20 mesh, which may be obtained from hardware dealers, or dealers in chemical supplies or wire cloth. The length of this cylinder should be equal to the height of the can minus the depth of the inserted portion of the lid. Secure the gauge to the wooden ends by small *iron* tacks as indicated, sewing the ends of the gauze together with fine iron wire. Copper tacks or wire must not be used, as local currents would be set up within the cell, which would result in a rapid exhaustion of the electrolyte and destruction of the gauze.

Insert the gauze cylinder within the can and fill the surrounding space with clean, dry, *cast* iron turnings or borings which are free from oil or rust. Pack them well in with a small stick, but do not bend the sides of the gauge cylinder.


3/16 Larger than diam. of can.
a
b
c
d
3/8
1 3/4"
3/8"
Layer of Paraffine Oil
Solder
Iron wire gauze cylinder
Zinc
Electrolyte, Caustic Potash.
Iron turnings.
Tin can.

The borings should be of such a size that they will not pass through the gauze used for the cylinder. Tack a piece of the same gauze over a box of some sort, so as to make a sieve, and sift all the material in it. This will allow all the dust to fall through, and what remains can then be packed in the cell. The fine material would otherwise sift through, and lie on the bottom of the cylinder, which would serve to short-circuit the cell.

These borings may be obtained from most machine shops for the asking, but they are apt to be oily and should be cleansed before using, as the oil and electrolyte will combine chemicaly, thus weakeningthe latter. They may be cleaned by boiling them throughly in washing soda and drying in an oven.

The zinc is of simple rod shape as used in the common forms of sal-ammonic batteries, and cost but little. The amateur may cast them from scrap zinc if he so wishes, but they may be secured so cheaply from electrical dealers that little can be saved. Little advantage can be gained by amalgamating the zincs.

When the anular space is well filled, a washer made of a piece of sheet tin may be placed over the whole although this is hardly necessary. The electrolyte may now be poured in, being made as follows:

It is a solution of caustic potash (potassium hydrate) in water. It is a powerful agent, and as its name indicates, very caustic in its action upon the skin and other organic substances. Great care should therefore be taken in using or making the solutions. It has a great affinity for carbonic acid gas and will absorb it from the air upon contact.

The ordinary commercial variety is good enough for the purpose, and more should not be gotten than is necessary as it is very deliquescent. This variety usually contains about 15 per cent. of its weight of water and allowance must therefore be made for it in the solution. The present solution should contain about 40 per cent of the alkali. Therefore to each pint of solution required there should be one-half pound of the salt. This solution will have about the percentage composition given above.

When this solution is made, put the zincs in place and pour the solution in until within an inch of the top, and pour on this a layer 1-4″ thick of heavy paraffin oil which effectivally prevents the solution from absorbing carbon dioxide from the air or evaporating

Set the cells up in some permanent location and connect them in series. Be sure that the cells do not touch each other and that the board upon which they stand is perfectly dry. Pieces of glass (old negatives) can be put under each cell.

The E. M. F. of this battery is a little more than 1 volt, and as the internal resistance is not much over .5 ohms per cell, it will give a current of about 2 amperes and discharge at a very steady rate.

SOUND BOXES FOR GRAMAPHONES.

C. T. Steel.

In Amateur Work for July, '02, appeared a description of a cheap gramaphone. The sound box therein described is not one calculated to give good results. A pill box is better suited for the purpose for which it was originally intended, and when used for a sound box, might be more fairly described as a noise producer, especially if the stylus-bar is, as directed, firmly attached to the sound box. As a result of a good deal of experimenting, I conclude that the stylus-bar should be free to vibrate, and that the part touching the diapraghm should be very small. The sound boxes I now describe can be easily made, and will give good results, but they cannot be made without a lathe and a small screw plate.

Fig. 1, represents a section of the sound box, and Fig. 2, a section of its cover, turned from any hard wood. A shallow recess is formed at *A*, to take the diaphragm, the latter being 1 1-2″ broad. The part *B*, should be turned to fit in the end of horn, and a hole about 5-16″ drilled right through. This part may be made separately, and glued into the front. The cover (Fig. 2,) is 3-16″ thick, 2″ outside, and 1 1-4″ inside diameter. It is attached to sound box by three equi - distant 3-8″ brass round headed screws. The stylus-bar *C*, is of 1-8″ (round) brass rod, about 1 3-4″ long. A hole is drilled up one end, the size of a gram-

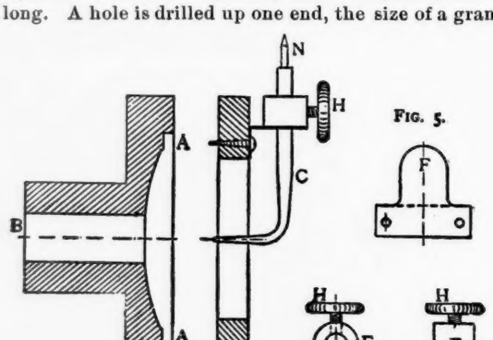


Fig. 1. Fig. 2. Fig. 3. Fig. 4

aphone needle, and should be about 3-8″ deep and slightly countersunk. The needle should go in easily, almost loosely. The other end of the stylus-bar is

tapered off to about 1-20″ at its extremity, and at about 3-8″ from this end it is bent at right angles.

The stylus-bar holder, or support, is shown — a front view in Fig. 4. A piece of thin springy brass, not more than 1-64″ thick, is cut to the shape shown in Fig. 5, and to it is soldered at *F*, a piece of brass, 1-4″ diameter and 3-16″ thick; then a 1-8″ hole is drilled through the centre to take the stylus-bar. Another small hole is drilled at top, tapped, and provided with a screw with a milled head. The thin brass *F*, is then bent at right angles along the dotted line, and two small holes drilled, as shown, to take very small 1-4″ wood screws. When soldering on the boss *F*, use as little heat as possible, so as not to destroy the springiness of the brass.

The diaphragm is of very thin celluloid; old negatives answer very well. It must be secured in place between rings of rubber or thick blotting-paper. I prefer the latter, for rubber, unless it is very thin, has a tendency to buckle the diaphragm. The rings should be 1 1-2″ diameter, with a hole 1 1-4″ thus being about 1-8″ broad. In putting together, the diaphragm should be placed in the recess *A* with one or more rings on each side of it.

The number of rings used is immaterial, and depends on the depth of the recess *A*, and the thickness of the rings and diaphragm. Both the rings and the diaphragm may be easily cut with a pair of scissors.

To fix on the stylus-bar support, put in one screw; then put the stylus-bar *C*, in its place, see that the point of it comes to centre of diaphragm, then the proper place for the second screw will be seen. Now hold the stylus-bar in position, remove the screw *H*, and drill through its hole into the stylus-bar until it goes clear into the needle hole; enlarge this hole slightly, or reduce the end of the screw *H*. Now replace the screw, which should pass right through, and clamp the needle *N*, and, at the same time, firmly hold the stylus-bar. Bend the bar up or down, as required, so that the bar *just touches* the diaphragm. The springy brass will allow this to be done easily. Try this sound box on a record; it should, if all is right, give a fairly good result. If not, it may arise from (1) the diaphragm being packed too loosely; (2) packed too tightly, especially if rubber rings are used; (3) the spring *F*, being too hard or too soft; (4) the stylus not just touching; or (5) some loose screw or fitting. The remedies for 1, 2, and 4 are obvious, for 3, if spring is too hard it can be eased by filing the sides — that is, made narrower. If too soft, it has been spoilt in the soldering; and, as regards 5, see that every screw is driven home. If all is satisfactory, put a little warm wax in centre of diaphragm under the end of stylus-bar, so that the latter will be stuck to it, and when hard, should hold tightly to the diaphragm, which can be proved by moving the bar slightly up and down gently with the fingers.

If the sound box is spoken into, not blown into, at the end *B*, whilst the needle is touching the palm of the hand, a ticklish sensation will be felt, showing the vibrations of the needle. The sound box, as described gives a very clear tone, not loud, but enough for a room 16′ square, provided not too much conversation is going on at the time. The appearance of the box may be improved by polishing or varnishing, and by substituting a brass cover for the wooden one, anything between 1-20″ to 1-8″ thick; but the stylus-bar support should be screwed or riveted on. It is difficult to solder firmly in place without destroying the spring.

If the whole of the sound box is made of brass, the sound produced is very much louder and richer in tone. I have heard no better amongst some supposed to be worth $5.00 each. In this case it should be made smaller than shown in drawing. It can be made of 1-4″ brass turned down to about 1 3-4″ diameter, 1-8″ thick at the edges, and the curved hollow from the recess to the centre made much more shallow, and the same curve followed on the back. At the hole in the middle it should be 1-8″ thick, and the hole just big enough to take in a short piece of 1-2″ thin brass tubing, which should be soldered in. On this tube a wooden ferrule should fit tightly, the outside turned to fit into horn, or, instead of the brass tube, it may be of wood, as shown at *B*. The cover is about 1-16th″ thick, the same diameter as box, and is held on by very small screws, certainly not more than 1-16″ thick. The rests of the parts, as already described, except that the bent part of *C*, will not need to be so long — 3-16″ should be enough. The diaphragm is better if of mica, but should not exceed .005 thick. If of celluloid, it may be even slightly thicker. The stylus-bar may be made of steel, but gives no better results than brass, and the latter is easier to work.

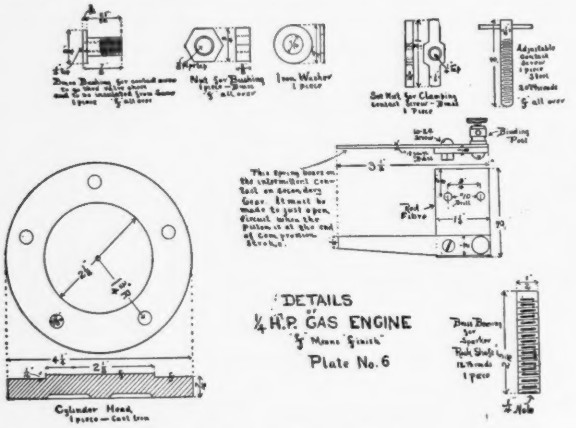
I have made a box in brass, taking a 2″ mica diaphragm, but there is scarcely any appreciable difference between it and the smaller brass one; but I have one in wood with a 2″ diaphragm that has a marked difference from the other. The peculiarity is that it seems to bring out just what I might call the minor instruments in band pieces; the accompanying instruments as it were; and blends them all equally in an agreeable manner. It is louder than the smaller wooden box, but not so loud as the small brass. It is not so suitable for songs; the voice seems to be weaker and the accompanient too loud. Very good results may be got by using parchment for the diaphragm. In this case, it is necessary to turn the cover with a ring on its underside, which ring will fit loosely in the sound box. A piece of good parchment, at least 3 or 4″ across is stretched across the cover on the ring side, after being thoroughly wetted. The ends are turned up over the edge of the cover, and firmly tied to the edge with string. When still wet, it is fixed in place on sound box, and when dry, untied, and the loose edges cut close to the box.

1-4 H. P. GAS ENGINE.

I. CYLINDER HEAD, PISTON AND CONNECTING ROD.

As the cylinder is furnished, bored out and faced off, there is but little work to be done on it, and it is best to set it aside until most of the other pieces have been finished.

It is well to begin with the easiest operations first, leaving the more difficult ones to the last. The cylinder head is a good piece to begin with.



Catch the cylinder head in a three or four jaw chuck and take a light cut off where it is marked *F*, on the drawing. You will notice on the two upper surfaces the letter *F*. This always means *Finished*, and whenever you see this letter on a drawing it means the surface so marked is to be turned or planed smooth. Turn the inner offset so that it just fits inside the bore of the cylinder, and allows the cylinder head to fit snugly against the end of the cylinder. The outer edge and outside of the head are to be left rough. With a pair of dividers lay off a circle 1 3-4″ in radius, with the centre of the cylinder head as a centre. Lay off five points on this circle at equal distances and drill a 5-16″ hole at each.

These holes are for the screws for fastening the cylinder head to the cylinder. The cylinder head is now finished.

Take the piece of 1-2″ brass rod, 3 1-2″ long, and chuck it in your lathe so that it runs true. Drill a 1-4″ hole clear through it from end to end. Then cut a standard 1-2″ - 12 thread for a distance of 2 1-8″ from one end. Lay it aside until you come to finish the cylinder.

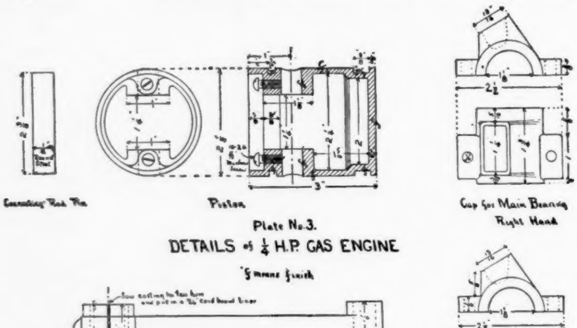
You can next make most of the small pieces that are used in the sparking apparatus. Take the 1-4″ round iron and cut off a piece 2″ long. Thread this with a standard 1-4″ die for a distance of 1 3-4″.

A small hole is to be drilled in the unthreaded end and a short pin No. 36, iron driven in it to twist it by. The "set nut" shown next to it is to be made from the piece of 1-2″ x 3-16″ brass, tapped to fit the thread on the contact screw previously made.

The hexagon brass nut is to be made from the piece of hexagon brass rod and is to be tapped out with a 1-8″ Standard pipe tap for about one half the distance of the threads on the tap.

The brass bushing shown next to the nut should be first drilled and tapped in the lathe and then turned off 7-26″ in diameter and the threads chased in the lathe. Cut 26 threads per inch to fit the nut. This bushing must have a shoulder 3-32″ thick left on it 3-4″ diameter, the same diameter as the original brass rod from which it is made. The entire length is 7-8″.

The spring wipingcontact is next in order. Cut a piece of red fibre1-8″ x 1 1-4″ x 2″ as shown and layoff two holes 3-4″ apart 5-8″ from the narrow side. Drill the holes with



a No. 10 drill. Cut a piece of flat spring brass about 4″ long, and fasten to the opposite end of the fibre piece as shown, using a 10-24 Round Head Iron Machine Screw with nut and also the binding post as shown. Leave thebrass spring long. It will have to be trimned and bent when finally attached to the engine.

The two bearing caps shown on page 6, are to be drilled with a 1-4″ drill for the 14 - 20 machine screws.

The piston is next in order. You will notice a small boss about 3-4" in diameter on the centre of the head of the piston. Chuck the casting in the lathe and true up this boss and face up the head. The boss is to hold the piston while turning it and is necessary in order that it may be turned from one end to the other. Hold the piston in the chuck by means of the boss and turn it off very carefully until it is a very nice close fit in the cylinder. It must not be a loose fit but must be so that it can be pushed in and out freely without any side play. At 1-2" from the open end turn a groove 3-16" wide, and 1-8" deep.

At 1-8" from the other end turn a groove 3-8" wide, and 1-8" deep.

At a distance of 1" from the open end mark off a very light scratch around the piston. The way to do this is to set a pointed lathe tool against the piston at the desired distance and turn the lathe by hand for one revolution. Looking into the end of the piston two bosses will be seen on the inside. These are for the 1-2" pin which passes through the end of the connecting rod. Drill a 1-2" hole through these two bosses laying off the centres on the circle previously scratched on the outside of the piston. It is necessary to drill this hole in the lathe holding the drill in the chuck on the lathe spindle and the dead centre in the centre on the piston. By this means the hole will be at right angles to the axis of the piston.

To finish the connecting rod, chuck the large end in the lathe and bore it out to 1" diameter. Then mount it on a mandrel and face off both sides so that it measures 1" from face to face. Measure off a distance of 6 1-16" from the centre of the large hole and mark a centre on the boss at the small end at this distance. Clamp the connecting rod to a drill press table and drill a 1-2" hole through the small end. Square up the connecting rod carefully so that the two holes are parallel.

At the large end or crank pin end drill and tap the two holes for the 1-4" stove bolts as shown. Then saw the connecting rod in two where the two heavy black lines are shown.

It is now ready for the brass sleeve. The piece of 1" brass tube 3-4" inside is to be faced off an even 1" in length, and then sawed in two lengthwise. These two shells are to be fitted into the end of the connecting rod and each piece should have a small 1-8" iron pin driven through it into the steel of the connecting rod to keep it from turning.

Cut off the 1-2" cold rolled iron rod to 2 3-8" and push it through the piston and piston rod. Two 10-24 Round Head Iron machine screws tapped in the bosses of the piston will hold this pin from working loose.

The castings for this engine may be obtained of Carlisle & Finch, Cincinnati, Ohio.

A 1-4 H. P. HORIZONTAL ENGINE.

B. R. Wicks.

VI. CROSS HEAD SHOES AND WRIST PIN.

The 1-4" hole for the cross head shoe stud, No. 385, should be laid out on both sides of the 1-2" thickness, and drilled first with a 1-8" drill, followed with 15-64", then reamed to 1-4" a reamer.

In drilling the 3-32" hole for the 3-32" key, stop up the 1-4" hole with a piece of brass rod, and make a prick punch mark, the location of which is given in drawing, so that half of the hole will come in the 1-4" hole and half in the brass plug. The body, the sides, and the 5-8" round ends can now be drawn, filed and polished with emery cloth and oil, all the machine work being done.

The cross head shoe stud, No. 385, is centred and turned up between centres. The 1-4" diameter should be at least one or two thousandths large for a drive fit in the cross head, and a thread cut on each end to receive the lock nuts. This thread should be made 7 32-30 threads per inch in place of 7 32-24 as given in drawings. The four nuts are faced to 1-16" wide, and the thread cut on the stud so that the nuts can be screwed on with the fingers.

Have at hand a piece of brass and drill a 3-16" hole in it to fit the ends of the stud to make this a good fit without any hole. The stud can now be tapped in position and the 1-8" piece No. 386, driven in.

The wrist pin, No. 389, is turned between centre to the figures given in drawing. Make a good fit without any shake in the 1-4" hole in the cross head and polish. Face up the nut to 3-16" wide and cut a thread 7-32" long, in the end. In the side, drill for the 3-32" key about 3-32" deep to keep the pin in position when the engine is in motion.

The cross head shoes, No. 388, should be turned in the lathe but they can be filed and scraped to a bearing. Plane or file the two shoes to 1" long, 1 1-16" wide, and 7-32" thick, by using a pair of calipers both pieces can be made alike. The radius of 1-4" can be laid out, by means of a pair of dividers, in each end and filed to the circle to a little more than 3-16" thick. The two 3-16" hole for the stud are laid out with a surface gauge as per detail, and drilled all the way through with a 3-16" drill. Take the cross head and

screw in the four lock nuts in the stud and place the two shoes in position in the stud; put them in the cross head guide and adjust the shoes, then push them back and forth in the guide, put in a little red lead to show the high places, take out and file a scrap until a full bearing is obtained, which finishes them with the exception of draw filing and polishing the sides and top.

The connecting rod No. 380, is straped to the lathe face plate by the two round ends made in the castings. Divide up the stock so that it will finish up central to 3-8″ wide. When the first side is machined, turn it over and take off the remaining stock, making it so that it will just enter the slot milled in the cross head.

The holes for the crank pin and wrist pin bushings are laid out central with the rod 4 1-2″ from centre to centre and drilled and reamed out on the face plate to 7-16″ and 9-16″.

The two bushings, No. 381 and 382, are chucked and reamed and turned on mandrels and faced to the same thickness as the connecting rod. These bushings must be made at least .002″ larger than the reamers so that they will drive. Put a little oil and drive them to the holes for the two keys can be drilled and the keys driven in. The holes for the adjusting studs are drilled and tapped 1-8″ 32 threads per inch, and the top counter-bored so that the lock nuts will set flush. Two oil holes must be drilled with 3-32″ drill. The two ends are to cut through the rod and bushings with a 1-32″ saw at an angle of 60° for taking up wear, on the wrist and crank pin.

The burr left by the saw and oil hole drill is then reamed out, and the rod fitted to the cross head. Push it back and forth on the surface plate, and scrap the two sides until a working fit is obtained. Put the wrist pin in its place in the cross head and connecting rod, and work it back and forth, and after taking apart, note if they are any places, if so, scrape off, doing this until an easy working fit is obtained without any shake.

The two studs, No. 383, are made from the 1-8 x ″ Fillister head machine screws, and the four nuts faced to 1-16″ thick. The crank disc, No. 371, is chucked, centred and drilled with a 3-64″ twist drill and reamed out to 1-2″ with a 1-2″ reamer, and forced on a 1-2″ mandrel and turned between centres to 3″ diameter, and 1-2″ wide. This piece should be highly polished with emery cloth and oil.

The 3-8″ hole for the crank pin, Nor 373, is laid out central with the 1-2″ hole and 3-4″ from the centre with a surface gauge, and fastened to the face plate and drilled with a 23-64″ twist drill and reamed out with a 3-8″ reamer then counter-sunk on the back so that the crank pin can be twisted.

The crank pin, No. 373, is turned between centres to figuring given in detail draiwngs; the 17-32″ x 3-8″ end must drive in the 3-8″ hole in the crank disc so leave .002″ large. The end that fits the crank pin pushing must be a good fit without any shake. A thread is cut on the end for the lock nuts, 1-4″ 20 U. S. S. The two nuts are faced to 1-8″ wide, and must be a good fit on the thread. The crank pin washer is drilled and reamed to 5-16″ and turned in a mandrel to 1 1-16″ diameter and 3-32″ thick. The crank pin can now be forced in its place and twisted. Put on some oil when starting it.

The two main bearing caps, No. 369, are held in the chuck by the chuck piece cast on them, and a 3-16″ hole drilled all the way through. Be careful to get this hole in the centre of the end bosses that hold the screws for fastening the caps to the main bearings. Place on a 3-16″ mandrel and turn to 13-16″ diameter and 3-32″ high. In the main bearings, No. 370, is a recess 3-32″ deep, and 13 16″ diameter to receive the caps when the bottom has been faced off.

HOW TO BUILD AN AUTOMOBILE.

WILLIAM M. FRANCIS.

V. CHANGE GEARS.

By refering to the plan of automobile, shown in the March number, it will be seen that the engine is not directly connected to the bevel gear driving the rear axle, but has a piece fitted to the face of the fly wheel, in which a friction cone fits. This is rendered necessary by the fact that in changing from one speed gear to another, the engine has to be disconnected temporarily from the driving mechanism until the clutch is shipped in; then the friction cone is again engaged with the fly wheel and the carriage proceeds at the new speed. In the drawing of change gears, the fly wheel, *a*, is keyed to the crank shaft with *b*, 1-4″ keys. The cone *b*, is bolted to the face of the fly wheel, with about 6 or 8 3-8″ caps bolts. The cone *b*, slides on two feather keys on shaft *h*. The cone is faced with leather where it engages with *b*, *c*, an oval washer, *c*, revolves loosely on the hub while *d*, is a washer which is screwed to the face of the hub. The studs which project loosely through the fly wheel are screwed and riveted into *c*, and between the nut of the studs and fly wheel is a spring which has tension enough to keep the friction cone continually engaged.

By pressing with the foot on lever *n*, motion is transmitted through the link and clutch lever *p*, to the cone

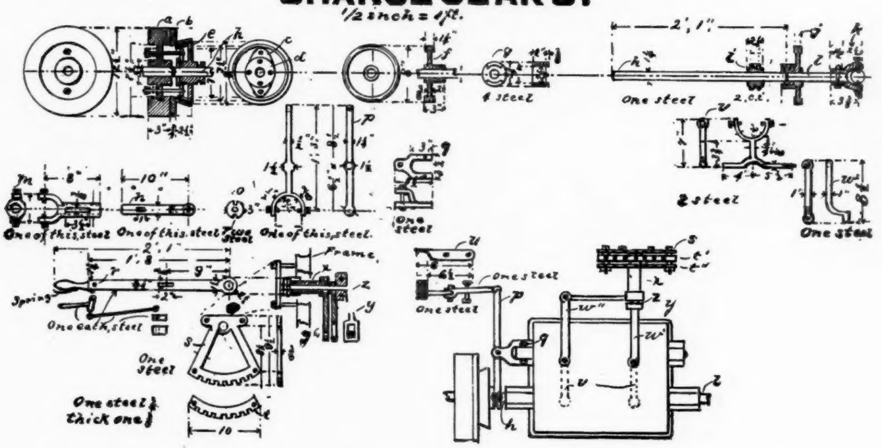
which draws it out of the cone. Lever *n*, is placed where it can be conveniently reached by either the right or left, using whichever is preferred, and the length of the link made to suit the conditions. The shaft *h*, passes a running fit through gears *h*, *g*, *f*, shown in the assembled drawing, (March issue,) and terminates in gear *e*, which is also marked *j*, in the detail drawing of charge gears. The two clutches *i*, slide each on two feathers, and gear *j*, is keyed to shaft *l*, which also has *k*, keyed to it, which is half of the universal joint *m*. Another half of the universal joint *n*, which is connected to the bevel gear shaft, slides loosely in *m*, so that it can slide endwise but is prevented from revolving except when turned by the cross key in *m*, which slides in the 3-8″ cross slot.

circle between the notched sectors *s t*. Lever *y*, is keyed to the other end of *z*, and by means of the slot in *y*, gives motion to lever *w*, which has a square hole in one end to slip on one of the clutch levers *a*. The other lever *v*, is bored a little larger, and is keyed to the hollow shaft *x*, which has *y*, keyed to it. This gives motion to the other clutch lever *v*, through the link and lever *w*, so by throwing one lever ahead gives a slow speed ahead, and back, the reverse; while the other lever ahead is a little faster speed, and back is the direct drive, or faster speed ahead.

The pieces *s t′ t″*, are bolted together at the top with a distance washer between, and bolted by the lugs at the bottom *s*, to the frame.

The gears here shown are respectively *d*, *e*, 4″ and

CHANGE GEARS.



8″ in pitch diameter; *c*, *f*, 6″ and 6″; *b*, *6*, 8″ and 4″; *a*, *h*, 8″ and 3″, with a 4″ intermediate. It is not necessary to use such large gears if they are made of steel, but this method is advanced as a cheap way to make a change gear system using stock cut geaas of cast iron, and the large size was selected in order that more teeth might be in mesh at once. The gear case is of cast iron with babbited bearings.

The ball *c*, has 4 holes drilled at right angles to one another to receive the points of the set screws shown at *k*, and *m*. These set screws should be provided with a lock nut to keep them from backing off. This also applies to the clutch levers *p* and *v*.

A section of *f*, gives one of the gears *a b c d*, shown in first issue drawing. These four gears are keyed to their shaft. The clutch gears *h g h*, are ordinary gears with a steel collar *g*, (change gear drawing) shrunk on the hub of each and pinned there. It will be seen that if shaft *h*, is revolved, and one of the clutches is engaged with *h g* or *f*, motion is transmitted to *a b* or *c*, as the case may be, which turns gear *d* and *e*, and thus to the differential, through the universal jointed shaft. The other gears which are not engaged by a clutch on shaft *h*, meanwhile turning loosely, but if the clutch is engaged with gear *e*, motion is transmitted directly from the engine to the universal shaft making what is known as the direct drive. Gear *h*, does not mesh directly with *a*, but has a small intermediate interposed, this is the backing gear change. Lever *v*, is keyed to shaft *z*, and moves in the arc of a

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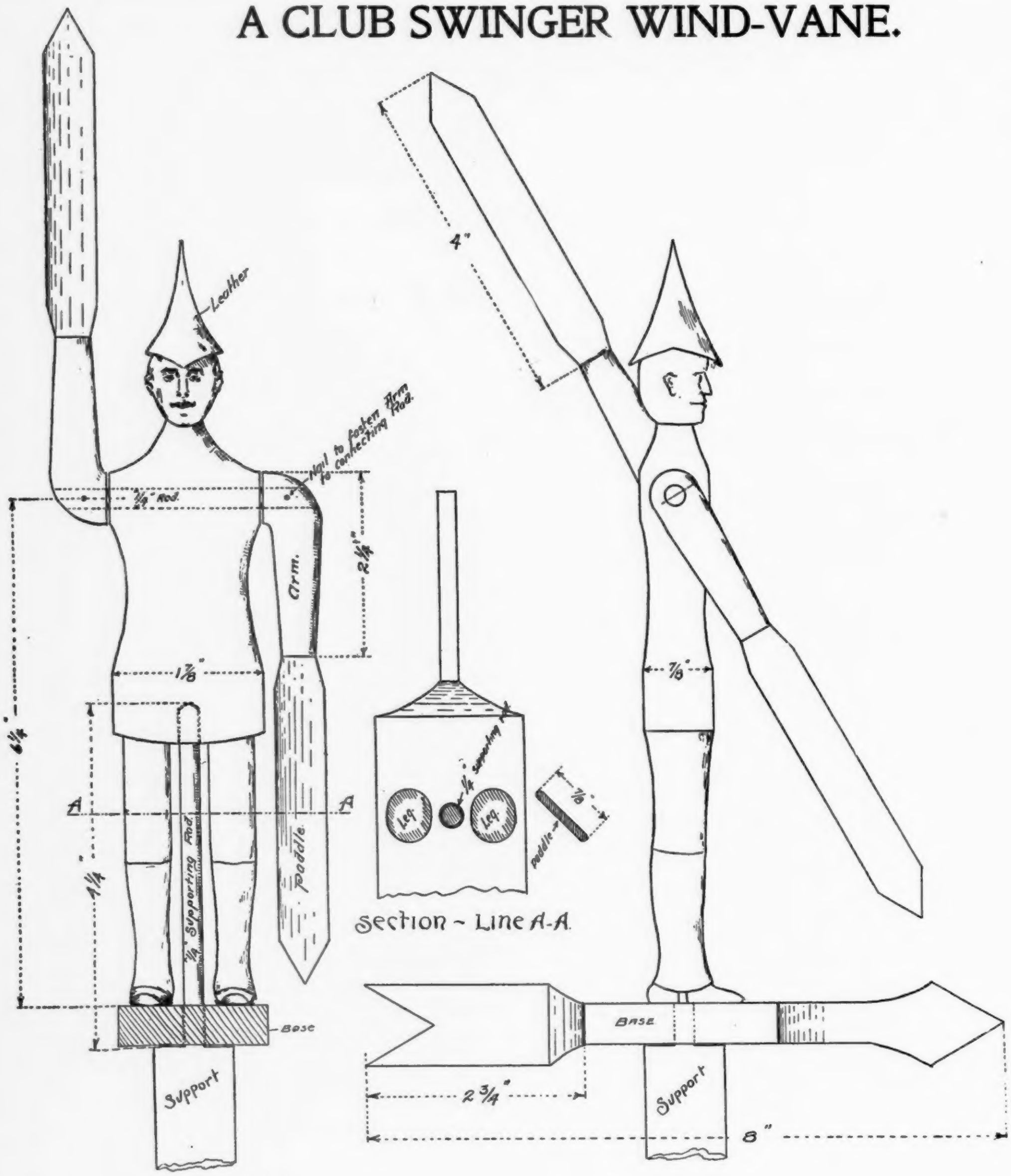
An international office of weights and measures is to be established in Sevres, France. Its object is the establishment, verification, preservation and manufacture of the international standard. The standard meters are mode of iridio, platinum, an oblong of 90 per cent platinum and 10 per cent iridum, and are shaped like an X in cross section which form has been found not only the most economical but the least efected by changes in temperature.

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

A CLUB SWINGER WIND-VANE.



A CLUB SWINGER WIND VANE.

W. J. LYLTE.

An amusing as well as a handy weather vane is the "Club Swinger." Any boy with a sharp knife can make the above with little trouble. Any sudden changes in the wind will cause it to do all kinds of movements that are very amusing.

The lower limbs, body and head are of one piece of wood, 7-8″ thick, 1 7-8″ wide, and 8 1-4″ long. A piece of shoe leather formed into a helmet can be tacked upon the head. A tassel at its apex will improve it somewhat.

A 1-4″ hole is to be bored through the body at the shoulders to receive the rod connecting the arms. This hole can be burned through with a red hot wire if the necessary bit or drill cannot be procured. The connecting rod can be of wood or wire, and long enough to extend through the arms at the shoulders. It should not be made to fit the hole in the body too tight, as it must have free movement to turn.

The arms and paddles are of one piece and securely fastened to the connecting rod at the shoulders; one arm to extend upwards and the other downwards. There should be enough play between the body and the arms at the shoulders to give both arms free movement.

The figure should be well fastened to the base at the feet. The base is of one piece and is made to show the direction of the wind and also to hold the body in position to allow the arms to receive the proper force of the wind.

The whole is placed upon a support as shown. The support can be fastened to a pole or projection of the house, where the wind can reach it. The rod of the support extends up through the base and into the body where it should support all the weight.

Any trimmings, painting etc., can be added to it if desired.

TOOLS AND THEIR USES.

Bits, Use of, The use of bits in bit-braces for boring holes is such a common operation, that but little can be said, which is not already familiar to the reader. The essentials in such are; that the holes shall be bored in the correct direction, and to avoid splitting the wood on the side where the bit comes out, should the hole be put clear through the wood.

To secure accuracy of direction, it is desirable, after the hole is well started, to test the position of the bit either with the eye or with a square, making the observations from two positions at right angles to each other. This can be with the eye by stepping back from the work far enough to be able to clearly see the angle at which the bit is working. Where extreme accuracy is required it is best to use the square. When a number of holes are to be bored in a piece of wood, especially if the wood be round, a piece the size of the hole placed in the first hole will serve as a guide to bore the remainder.

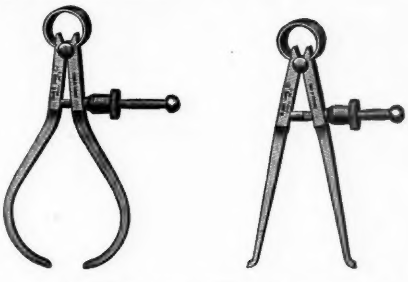
If a hole is to be bored through a board, splintering may be prevented by placing a piece of waste board under the place where the bit is to come through, and continuing to bore until the spurs of the bit are through the upper piece.

In boring holes with the grain of the wood, it is desirable to clear the bit at intervals if the hole is a deep one, by removing the bit, drawing the chips with it. This is done by giving a backward turn until the spur is free; then turning forward again as though boring, when pulling out the bit.

To bore a number of holes of a eertain depth, but not through a piece, use the depth guage. If one is not available, a very good one can be made by boring a hole through a piece of wood which is the proper length to allow the bit to project the necessary distance beyond one end, while the other rests against the chuck of the bit-brace.

Blow Pipe. The blow-pipe, usually some form of Bunsen burner, is much used for soldering and brazing. The more common forms require foot-bellows to supply air and gas from the city mains. A smaller kind, used by jewellers, is worked with an alcohol lamp, the air being blown from the mouth. It requires considerable practice to keep up a steady jet, breathing causing breaks which reduce the effectiveness.

Blow Torches. For many kinds of work the blow-torch has replaced the blow-pipe, being portable and easily operated. The larger sizes use gasoline, burning about 1-2 pint per hour at full blast. Air pressure is secured by an air pump, forming a part of the handle. A large, intense blaze is secured which is used to heat soldering irons, solder joints, remove paint, etc. In the smaller sizes, to carry in the pocket alcohol is used, air being supplied from the mouth through a rubber tube.



Outside and Inside Calipers.

Calipers. "Outside" calipers are used to determine the outside dimensions of objects. In wood-turning they are of the utmost importance. "Inside" calipers are used to find the diameters of holes. Those illustrated are of the "spring" type, allowing adjustment to be easily and quickly made.

CORRESPONDENCE.

OUR readers are invited to contribute to this department, but no responsibility is assumed for the opinions expressed in these communications.

Letters for this department should be addressed to editor of AMATEUR WORK, 63 Kilby Street, Boston.

They should be plainly written on only one side of the paper, with a top margin of one inch and side margins of one-half inch.

The name and address of the writer must be given, but will not be used, if so requested.

Enclose stamps, if direct answer is desired.

In referring to other letters, give the number of the letter referred to, and the date published.

Illustrate the subject when possible by a drawing or photograph with dimensions.

Readers who desire to purchase articles not advertised in our columns will be furnished the addresses of dealers or manufacturers, if stamp is enclosed with request.

(No. 50.) ADDITIONAL ANSWER.

As the opinions of several engineers differ from the answer given in the last issue to this question, the following additional information is inserted, being the answers received from another engineer to whom the questions were submitted. EDITOR.

The cut off should be considerably later than tha given or at an average of not less than 5-8″ stroke for the two ends. The cut off will not come equal on both ends without great disparity in the leads and is apt to come longer on the top end. A cut off at 5-8 stroke will allow the engine to develop its full power, which it could not do with an early cut off. The head should be considerably greater on the lower than on the top end. The use of a riding cut off valve, while very satisfactory on large, slow running stationary engines, is very little used in marine practice, and would be entirely out of place on such a small engine. A plug piston valve for the H. P. and a larger piston on slide valve for the L. P. will be found to give the most satisfactory results.

(No. 51.) WASHINGTON, D. C. May 21, 1903.

Please give me a simple method for computing the horse-power of a small water motor.

R. F. .C

To give a formula which would be correct for all forms of water motors would be impossible, but the following is one which will give the power developed by a jet wheel, such as the Pelton type.

$$H.\ P. = \frac{W.\ Q.\ H.\ E.}{33000} \text{ in which}$$

H. P. = horse-power delivered

W. = weight of water per cu. ft. – 62.36 lbs.

Q. = quality of water in cu. ft. per minute

H. = effective head in feet

E. = efficiency of water motor

(No. 52.) SPRINGFIELD, VERMONT. June 5, 1903.

1. Will you please inform me why it is that when I connect the wires leading to the copper plate in the air and the wire to the ground, to the terminals of a 3-8″ induction coil, I only get a little spark, but after disconnecting either the ground or air wire it is as large as ever. What size wire should be used and is it necessary that it should be insulated?

E. B. M.

1. You probably have a ground in one of your wires. Try insulating the coil by standing it on a glass plate. Insulate the aerial wire thoroughly. If the lead was very long its capacity might cause the difficuly you mention. Place the discharge balls of your coil very close together. 2. For such a small coil No. 12 or 15 wire would be sufficiently large. Insulate the aerial wire until above surrounding objects; above that it may be bare.

(No. 53.) PROVIDENCE, R. I. June 8, 1903.

In the latest edition of the AMATEUR WORK, it was stated, that a chloride of silver battery, suitable for a necktie light, was explained in the November, 1902, number of this magazine. Now as I can't find it in that magazine I wish you would please send me directions for making one of these batteries.

L. C. K.

Directions for making a chloride of silver battery are contained on page 281 of the October, 1902, issue of AMATEUR WORK.

(No. 54.) LAKEPORT, CAL. June 3, 1903.

Will some of your readers give me a drawing of a bicycle wheel truing device such as is used in factories for truing wheels in both a vertical plane and with regard to the center.

H. L.

Anyone who can give this information should send same to Editor of AMATEUR WORK. This department can be made of much value to readers if they would respond to inquiries when able.

(No. 55.) WILLIMANLIC CONN. June 1, 1903.

Will you please give me the name of a manufacturer of storage batteries? Have you published any articles on the building of a dynamo?

H. R. T.

Write the Manhattan Electrical Supply Co. 32 Cortland St. New York City, or Seth W. Fuller Co. Devonshire St. Boston. An article on dynamo building is in preparation and will be published soon.

(No. 56.) EAST BOSTON, MASS, May, 1903.

Please tell me where I can buy vibrators and handles for induction coils?

H. D. H.

The Manhattan Electrical Supply Co. 32 Cortland St. New York City, list these in their catalog.

BOOKS RECEIVED.

PRACTICAL ELECTRICS: 135 pp. 75 cents. Spon & Chamberlain, 123 Liberty St., New York City.

The scientific amateur who is interested in electrical matters will find in this book, a fund of information of a useful and practical character. Such matters as alarms, batteries, bells, coils, small dynamos and motors, microphones, telephones, etc., are among the subjects presented with suitable illustrations when necessary.

ALGEBRA SELF TAUGHT: W. P. Higgs, M. A., D. S. 100 pp. 60 cents. Spon & Chamberlain, 123 Liberty St. New York City.

The number who regret that they omitted or neglected algebra during their school years is large, and this regret is frequently emphasized in later years when the necessity of a working knowledge of algebra becomes evident. To this class, such a book as this is invaluable, especially when the subject is presented in such a clear and attractive way as the author has succeeded in doing. Those who find themselves in need of a command of the algebraic formulas and methods in more common use cannot do better than secure and study this book.

PROJECTION DRAWING: Oswald Gueth, M. E. 12 plates, 75 cents. Spon & Chamberlain, 123 Liberty St. New York City.

Those who have been interested in the series of articles on "Projection" now being published in this magazine, will find in the exercises given in the twelve large plates, excellent supplementary work. A personal examination of them is necessary to fully appreciate the wide scope which they cover, and the very complete way in which the subject is covered. Teachers of this subject will find much of value to include in their class work. Beginners in drafting rooms will also find it a valuable guide.

DAVIDS PRACTICAL LETTERER: Sidney Hackes and Arnold Binger. 100 pp. $1.00 Thaddeus Davids Co., 127 Williams St. New York.

The art of lettering is now so much a part of the regular requirements of the larger stores throughout the country, and the number desiring a knowledge of it so numerous, that this book, though but lately issued, is meeting a large sale. Anyone with a little artistic ability can, with the help of the directions, illustrations and examples given, readily fit themselves to do good work in card writing. Numerous illustrations from photographs make the directions, which are also very complete, an excellent book of instruction. The examples of cards given on 26 full page plates, and alphatets on 24 full page plates, provide ample material for the beginner.

TRADE NOTES

Teachers of Manual Training are invited to write to the Simonds Mfg. Co., Fitchburg, Mass. for one of their souvenir watch charms and booklet on "Hand Saws", both of which they will find well worth having.

Carlisle & Finch Co., Cincinnati, Ohio, announce that a new model steam railway; the engine being of the Atlantic type, is in process and will be ready for the fall trade.

The battery fan outfit of the Ohio Electric Works, Cleveland, Ohio, is something that should receive attention during the warm weather now upon us. Comfort can be secured at small expense with one of these fans.

The catalog of the Manhattan Electrical Supply Co., 32 Cortlandt St. New York Gity, should be in the hands of every electrician whether amateur or professional. It will be mailed to anyone requesting it.

Spon & Chamberlain, 125 Liberty St. New York City, have a large assortment of books of interest to the scientist, electrician or mechanic. If you have difficulty in getting books upon any particular subject, a letter of inquiry to them will secure a prompt reply. A monthly bulletin of new books may be obtained upon request.

A protractor for draftsmen is one of the many special drafting tools to be obtained of Kolesch & Co., 134 Fulton St. New York City. A new catalog showing many new things in drafting instruments either singly or in sets is now in press and will be ready for mailing soon. Every draftsman should have a copy.

To file a saw correctly ordinarily requires long experience which the amateur, and oftentimes the professional, wood worker has not the opportunity of acquiring .With the saw filing gnide here illustrated, and manufactured by Henry Disston & Sons, Philadelphia, Pa. a saw can be accurately and well sharpened by anyone who will give proper attention to the directions for using same. Any shape of tooth can be filed to a uniform size, this being the obstacle encountered by the novice when working without a guide. Our readers will find this a very useful tool. It is to be added to the premium list, and given for four new subscribers, postage 20 cents extra.

The Frasse Co. 38 Cortlandt St., New York City, make a specialty of carrying supplies for amateurs. Car wheels in several sizes and forms for model railways, all the parts of a small steam engine, journals for small machines, etc., are but a few of the things in this line. Small milled head screws of various sizes can also be had. If you want anything out of the usual run, as well as general hardware, write to this company.

CONTENTS OF BACK NUMBERS.

NOTE.

In addition to above are Studies in Electricity, November, 1901, to April, 1903. Mechanical Drawing, November, 1901, to June 1902. Projection, September, 1902, to date. Wood Turning, September, 1902, to date. Shop Practice, January, 1903, to date.